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Gerard G. Back, Craig L. Beyler, Philip J. DiNenno, Richard Hansen	R&DC – 427

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Hughes Associates, Inc. 3610 Commerce Drive, Suite 817 Baltimore, MD 21227-1652	U.S. Coast Guard Research and Development Center 1082 Shennecossett Road Groton, CT 06340-6096	11. Contract or Grant No. DTCG39-97-F-E00150, Task Order DTCG39-00-F-E00015

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15. Supplementary Notes

The R&D Center's technical point of contact is Mr. Rich Hansen, 860-441-2866, email: rhansen@rdc.uscg.mil

16. Abstract (MAXIMUM 200 WORDS)

This report provides an evaluation of the firefighting capabilities of fixed pressure water spray systems for machinery spaces as described in Regulation 10 of Safety of Life at Sea (SOLAS). The objective of this evaluation was to determine if a system meeting the minimum SOLAS requirement can provide adequate protection of shipboard machinery spaces.

To meet this objective, the capabilities and limitations of twelve water spray systems were determined using the International Maritime Organization (IMO) test protocol for water mist systems (MSC 668 and 728) as the basis for this analysis. The tests were conducted in a simulated 500 m^3 machinery space onboard the U.S. Coast Guard's test vessel STATE OF MAINE.

Generally speaking, the trends in performance of water spray systems were similar to those observed for water mist systems. All systems were capable of extinguishing larger fires (4 kW/m^3 and greater) with variations in system capabilities becoming apparent as the fire size was reduced (2 kW/m^3 and below). Only about half of the systems were capable of extinguishing the 1.0 MW obstructed spray fire located on the side of the engine mockup (similar to IMO-6). Water mist systems typically exhibit slightly better capabilities primarily against the smaller fires.

It was concluded that the capabilities of these systems cannot be associated with a single parameter such as application rate and must be determined empirically. As a result, the approval of these systems needs to be performance based as with all other fire suppression systems required by SOLAS. It was recommended that SOLAS Regulation 10 be re-written to cover all water based machinery space systems with the caveat that they pass a modified IMO test protocol based on the one currently used for approving water mist systems [MSC 668 and 728].

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EXECUTIVE SUMMARY

The United States Coast Guard (USCG) has been actively involved in evaluating alternative fire suppression methods and replacement agents for Halon 1301 total flooding systems for machinery space applications. The research conducted to date includes evaluations of both the gaseous halon alternatives (halocarbons and inert gases) and water mist fire suppression systems. This experimental program was a continuation of this research and looked at the capabilities of water spray systems for machinery space applications.

The International Maritime Organization (IMO) allows the use of fixed pressure water spray fire extinguishing systems in machinery spaces per Regulation 10 Chapter II-2 of SOLAS (Safety of Life at Sea). Currently, the Code of Federal Regulations does not permit the use of fixed pressure water spray systems for vessels registered in the United States. Therefore, it was USCG's desire to determine if the systems meeting this requirement can provide adequate protection of shipboard machinery spaces.

The capabilities and limitations of twelve water spray systems meeting the minimum SOLAS requirement were determined using the IMO test protocol for water mist systems (MSC 668 and 728) as the basis for this analysis. The tests were conducted in a simulated 500 m^3 machinery space onboard the test vessel STATE OF MAINE located at the U.S. Coast Guard's Fire & Safety Test Detachment in Mobile, AL.

The trends in performance observed during these tests were generally similar to those of water mist systems. Both water spray and water mist systems rely on oxygen depletion to extinguish obstructed fires making larger fires easier to extinguish and go out faster than smaller fires.

The distinction between the two types of systems (mist versus spray) was observed for the smaller fires. The water mist systems had better capabilities against small fires than water spray systems. All of the water spray systems were capable of extinguishing larger fires (with volumetric heat release rates of 4 kW/m^3 and greater) with variations in system capabilities becoming apparent as the fire size was reduced (2 kW/m^3 and below). Only about half of the

systems included in this evaluation were capable of extinguishing the 1.0 MW obstructed spray fire located on the side of the engine mockup (similar to IMO-6). Most of the commercially available water mist systems are capable of extinguishing this fire.

The performance/capabilities of these water spray systems were shown to be linked to two parameters; vapor production and vent flow effects. In an actual installation where the space would be secured during a fire, the production of water vapor is the key parameter. As a result, the smaller the drops, the better the performance of the system (assuming good mixing).

A droplet evaporation algorithm was developed and added to the water mist fire suppression model developed and validated during previous USCG investigations ("A quasi-steady-state model for predicting fire suppression in spaces protected by water mist systems"). The modified model showed good agreement with the results of these tests and was used to define the capabilities and limitations of these systems as a function of drop size.

It was concluded that the capabilities of these systems cannot be associated with a single parameter such as application rate and must be determined empirically. As a result, the approval of these systems needs to be performance based as with all other fire suppression systems required by SOLAS for this application. It was recommended that SOLAS Regulation 10 be re-written to cover all water based machinery space systems (water spray and water mist), and require that these systems successfully complete an IMO test protocol such as the one currently used for approving water mist systems [MSC 668 and 728] or one derived from those incorporating the recommendations put forth in this report.